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Abstract

Investors who want to profitably trade stocks which they believe to be undervalued or overvalued are facing not just transaction costs: also cash constraints and short-selling restriction can hinder them. Intuitively, the more onerous friction may seem to be short-selling: borrowing shares from someone else and selling them looks more of a hassle than borrowing money or using an overdraft facility. By examining the observed forward premiums in the Brussels Stock Exchange during the period 1989-1996, this study aims at uncovering which of the two types of restrictions had the biggest impact on trading: how often was shortselling the dominant problem, what was the implied shadow cost of the imperfection, and how persistent were the symptoms?

We show theoretically that a positive forward premium is more likely in a situation in which the order volume from cash-constrained buyers exceeds that of sellers without a long position. Likewise, a negative forward premium typically means that the order volume from sellers without long positions exceeds that of cash-constrained buyers. We find empirically that abnormally high forward premiums are 2.5-3 times more frequent and larger than negative premiums, and that they persist in time, unlike negative premiums. Thus, contrary to what many academics may have expected, in the Brussels environment getting money loans seems to be a more frequent, more expensive, and more persistent problem than asset borrowing.

JEL G14, G15

Key words: dual markets, funding cost, shorting cost, market microstructure

Introduction

Investors who want to profitably trade stocks which they believe to be undervalued or overvalued are facing not just transaction costs, but potentially also cash constraints and short-selling restrictions. Intuitively, the more onerous of the latter two impediments may seem to be the one on short-selling: borrowing shares from someone else and selling them looks more of a hassle than borrowing money or using an overdraft facility. By examining the observed forward premiums in the Brussels Stock Exchange during the period 1989-1996, this study aims at uncovering which of the two types of restrictions had the biggest impact on trading: how often was shortselling the dominant problem, what was the implied shadow cost of the imperfection, and how persistent were the symptoms? This information can be obtained by exploiting a probably unique feature of the (then) Brussels market: until 1996, the Stock Exchange had two parallel trading tiers: a "spot" market tier with third-day delivery where all stocks were traded and, for the most active stocks, also a parallel "forward" tier with fixed-date delivery. The forward market was cheaper, deeper, unhampered by price limits, and fully computerized. More fundamentally, for us, it was the more convenient avenue for short sales and leveraged purchases.

In this paper we study the opening prices from the angle of what drives the observed forward premiums. The hypothesis that academics would first reach for is that the difference reflects pure time value. In our data, this effect is absolutely minute relative to the noise.[1] Anomalously, though, we find that abnormal forward premiums are strongly autocorrelated, implying that there are predictable price differences. We argue that, in imperfect markets, expected prices could indeed deviate by more than what transaction costs would suggest. One possible reason for excessive deviations is that potential buyers may be strapped for cash, in which case the automatic leverage implicit in a forward purchase would justify an extra forward premium over and above pure time value. Similarly, regular cash short sales were virtually impossible: there was no legal framework until the early 1990s, and the only option was to actually borrow shares first. Information-driven sellers that want to avoid the hassle and delay from a cash short sale would, for that reason, prefer selling forward instead and potentially trade at forward prices that are abnormally low relative to the time-value-adjusted spot price.

[1] The noise stems from the fact that standard spot-forward arbitrage was impossible. The reason is that both segments were order-driven, not quote-driven, and their opening prices were set via a call; so there were no firm bids and asks, implying that the usual no-arbitrage predictions about price differences should be weakened into statements about expectations.

In sum, the key idea in this paper is that, in imperfect order-driven markets, price differences could be primarily driven by convenience of financing or shortselling rather than by time value and the traditional type of transaction costs.

By looking at the frequency, size, and persistence of abnormally high v abnormally low price discrepancies we obtain clues as to which advantage the forward traders typically seek: the convenience of easy asset borrowing (as signalled by excessively low relative forward prices) or of automatic financing (indicated by high forward prices). We find that for virtually all stocks (*i*) the probability of positive forward premium is much higher than that of negative premium; (*ii*) the mean of positive premiums is higher than that of negative premiums in absolute terms; and (*iii*) autocorrelation of forward premiums given positive premiums is significantly positive and around twice as large as that of the negative premium. Thus, contrary to what many academics may have expected, getting money loans seems to be a more frequent and more pressing consideration than asset borrowing.

@@Our finding relates the literature on the possible impacts of 'funding liquidity' on prices and market liquidity, *eg* Brunnermeier and Pedersen (2009), Hasbrouck and Seppi (2001), Chordia, Roll, and Subrahmanyam (2005), Coughenour and Saad (2004), Comerton-Forde, Hendershott, Jones, Moulton and Seasholes (2008), Grossman and Vila (1992), and Liu and Longstaff (2004). In this paper, we found that funding liquidity has an impact on forward premiums.@@

The rest of the paper is organized as follows. Section 1 describes the markets and the data. In Section 2 we start from a standard noisy-price model and discuss some preleminary evidence from autocorrelations tests and an event study. Section 3 provides more detailed results and systematic significance tests for the phenomena observed in the event study. Section 4 concludes.

1 The Two-Tier Brussels Stock Exchange: Institutional Background

Brussels used to have not only its own stock market (the Brussels Stock Exchange (BSE), integrated into Euronext since 2001), but even a two-tiered one: a "spot" market tier with third-day delivery, and for the most active stocks a parallel "forward" tier with fixed-date delivery. There used to be twenty-four fixed settlement dates per year, implying that the trading periods typically lasted about two weeks, hence their name *quinzaine*, two-week period.[2] Details about the market organization are crucial for our analysis. In this section, we describe the price mechanisms in the forward and spot market and the delivery rules as they applied during the sample period.

1.1 The price mechanism in the forward tier

The forward market used to work via a pure public limit order book (which, during the sample period, was kept by a version of Toronto's Computer-Aided Trading System, CATS). Thus, although brokers were allowed to trade on their own account, they did not act as market makers, and their main role on the floor was to pass on the orders from the public to the exchange. At 9 p.m., the one-hour pre-market started, during which orders could be added or withdrawn and CATS displayed a continuously updated preliminary market-clearing price. Actual trading in the forward market started at 10 a.m., with a simultaneous call market for all stocks. That is, at 10 a.m. limit orders were matched as far as possible, and executed. For most stocks the opening represented a substantial part of the day's turnover. After the opening round, the interactive trading session or "continuous market" started (10:00-16:30). Throughout the continuous-market session, the four best unfilled limit orders on the buying and selling side were displayed on computer screens and could be taken up by any incoming new order. Only brokers saw the screens: at the time of the sample, individual investors just heard (or saw) the opening and close prices over the radio or on Teletext, at noon or in the afternoon. Orders could also be matched directly, between brokers or in-house, provided that the price was within the book's bid-ask spread and the trade was reported immediately to the exchange. Large trades, *i.e.* blocks of at least BEF 50m (EUR 1,250,000) could be crossed or traded outside the BSE (often in London or Paris), but had also to be reported immediately. There were no limits on consecutive forward price changes. Limit order and trade prices were rounded according to a schedule shown in Table 1. Until the 1996 reform, the exchange's minimum margin requirement for a forward trade was 25 percent, but the BSE left the enforcement of this rule to the individual brokers (who bore the default risk). Securities could be posted as margin; in fact, many investors left most or all of their stocks with a their broker—most shares

[2]The forward market has now disappeared, following a "$T \leq t + 7$ days" rule implemented internationally in the 1990s. London used to have a two-weekly fixed-delivery system too: Paris had delivery at the end of the month in its "forward" section for big stocks. (There also was a spot section for small stocks). Basel offered the choice between several delivery dates.

Table 1: **Tick Size in the Spot and Forward Market**

price range	price must be a multiple of	minimal percentage price change at lower end of scale	minimal percentage price change at top end of scale
BEF 1-500	1	100%	0.20%
BEF 502-1,500	2	0.40%	0.13%
BEF 1,505-5,000	5	0.33%	0.10%
BEF 5,010-10,000	10	0.20%	0.10%
BEF 10,025-50,000	25	0.25%	0.05%
BEF 50,050	50	0.10%	—

Key One BEF is approximately EUR 0.025.

are bearer securities—and used this portfolio as margin for forward positions. Thus, there was no opportunity cost associated with the margin.

Prices for all traded lots were shown, in sequence (but not time-stamped), in the official price list, a function later taken over by the financial dailies, *De Tijd* and *L'Echo de la Bourse*. In the electronic records, only open/close/high/low are available.

1.2 The Spot Price Mechanism

Due to its lower volume, the spot market was fully computerized much later (in 1996). Like the forward tier, it was order-driven but the implementation was more artisanal. First, there was no pre-market, so that the opening price was potentially much more subject to noise than the forward opening price even apart from volume effects. Second, because of the thinness of the market, for many stocks there was just one trading round per day; this subsegment of the spot market was called the '*parket/parquet*' market. A continuous market existed only for the more active stocks (quoted on the *"corbeille"* subsegment) and even this continuous market was not very active.[3] Third, there was no centralized public order book kept by the exchange. Rather, a few specialist brokers each kept their own books, and met sometime between 1 p.m. and 1.30 p.m. on the Exchange's floor to aggregate their information and identify the price that maximizes trade from the combined order book. Fourth, for stocks that were not traded on the parallel forward market, there were daily price limits of 5 percent (for very thinly traded stocks, traded on the *parket* segment) or 10 percent (for other stocks, traded on the "*corbeille*" market). And, in the *corbeille* market, subsequent intraday price changes could not exceed 5 percent.

The actual pricing and trading was organized by a BSE official who started by crying out a price proposal. This price proposal equaled the price that maximized trade from the order book if that price was within the price change limits. If not, the official announced the price limit itself. In addition to the price proposal, the official also announced the direction of the imbalance. If there was an excess supply (demand) at the proposed price, additional purchase (sale) orders from the floor were solicited to reduce the imbalance in the book. If the remaining imbalance between supply and demand at the price limit was less than 50 percent, the specialist would decide to 'reduce' most or all orders on the excess side, *i.e.* execute only part of each order. The transaction price was then published in the financial press with the qualification *"sellers reduced"* or *"buyers reduced"*. If, at the price limit, the imbalance between supply and demand remained huge, even after soliciting orders from the floor, there was no trade at all and the price limit was published as an indicative price. In practice, however, when the imbalance was only slightly larger than 50 percent, the stock's specialist brokers often added purchase or sale orders for their own account to prevent no-trade (and no-income) days.

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[3] *Corbeille*, meaning 'basket', refers to the tables with an unusual basket-like basis that were in that part of the floor. Parquet refers to the wooden floor covering.

As, around 1990, the spot market list contained about 300 stocks, the stock-by-stock opening-call prices were set more or less sequentially. The exact timing of each stock's spot fixing was not registered.

As mentioned, the spot market had two sub-tiers. For about half the stocks, those listed on the *parket* market with its less liquid stocks, the call was also the only price for that day. For stocks quoted on the *corbeille*, the fixing was followed by the traditional (blackboard-and-chalk) version of the continuous market: unfilled orders were chalked onto the blackboard and could be picked up from the floor, and orders could also be matched directly on the floor at a price within the book's spread. For the *corbeille* market, prices for all traded lots were shown, in sequence (but not time-stamped), in the official price list but in the electronic records, only open/close/high/low are available. For the *parket* stocks there is just the single price.

1.3 Settlement Rules

For the BSE, the other details of the actual settlement were similar for both market tiers. The buyer paid via a bank transfer rather than by check. This means that there was no "mail float" on the payment side. Still, the value dates for buyer and seller did not match perfectly: the buyer's value date is one day before the actual settlement day and the seller obtains value one day after settlement.

Delivery of the stock could mean actual physical delivery of the piece of paper, if the buyer desired so. Alternatively, the buyer could ask that his or her purchase be recorded with a netting and depository institution, the *Caisse Interprofessionelle/Interprofessionele Kas* (CIK). The CIK merely netted the physical deliveries across brokers if actual delivery is asked and held the paper on behalf of investors who did not demand physical delivery. Thus, the CIK was not a clearing house in the usual sense: it did not act as a central counterpart, nor did it cancel an individual investor's earlier purchases against subsequent sales (or *vice versa*) within one settlement period. There was some informal clearing by brokers, though: brokers did not exact delivery and payment for a forward transaction that was reversed later on via the same brokerage house and within the same quinzaine.

One function of the forward market, therefore, was to reduce the cost and hassle of mutually offsetting stock deliveries and payments for trades that had been closed out within the same quinzaine. This partly explains why, unlike in currency markets, the transaction costs for small trades in the forward tier were somewhat lower than in the spot tier (as illustrated in Table

Table 2: **Transaction costs, spot and forward, 1990**

item	cost of spot trades	cost of forward trades
+) BSE Commission	max(tradesize×0.03%, BEF 6 000)†	
+) Transaction Tax	max(tradesize×0.17%, BEF 10 000)	
+) Brokerage fees:		
- fixed part	BEF 200*	
- variable part:		
order BEF 1-5m	1%	.8%
order BEF 5m-10m	.8%	.6%
order BEF 10m-20m	.4%	.3%
order BEF 20m-30m	$\geq$ BEF 130 000‡	.2%
order $\geq$ BEF 30m	$\geq$ BEF 130 000‡	$\geq$ BEF 120 000‡

† : 40 BEF is worth approx. 1 EUR; * : plus BEF 100 for the buyer if physical delivery is asked; ‡ : negotiable, with the stated amounts as minima. Thus, around 1990 a rather small trade of BEF 250,000 (approx. EUR 6.250) would cost 1.29 percent spot, and 1.09 percent forward. For an order of BEF 30m (750,000 Euros), the cost difference may be as small as 10,000/30,000,000 = .033 percent.

2).[4] A second useful feature of the forward tier is that it allows one to take short positions until the end of the *quinzaine*, positions that could then be rolled over fairly easily. In Belgium, there was no formal legal framework for asset borrowing and spot short-selling until the 1991 Financial Market Reform Act, and even then the only organized facility was the opening by the central bank of a lending facility for Government bonds, accessible to the prime brokers who distribute and quote the bonds. For stocks, shorting in the cash market meant (and means) finding one's own asset lender; even nowadays, prime brokers might only be willing to help for big orders in big stocks. In short, the forward market provided the sole organized opportunity for short positions.[5] A third function of the forward market was to provide the equivalent of buying on margin: the actual payment was deferred until the end of the *quinzaine* (at which moment the forward contract could be rolled over) and the buyer just posted the 25 percent security. Since leveraged buying was possible in the forward market, no organized system of buying on margin was set up in the spot market.

[4] Another reason for the lower transaction costs might have been the fact that the forward market had vastly larger volumes than the spot market for the same stock, see below.

[5] There was even a centralized mechanism for asset lending in the forward market if, at the end of the *quinzaine* one wanted to roll over a short position. The solution was to borrow a stock (for delivery under the maturing contract), and to buy it back for the new forward date. Finding a lender happened in an organized session on the day of the *prolongations*. The agents settles his gain or loss, the difference of the initially contracted price and the settlement price at 1:30 p.m. on the last day of the *quinzaine*, and also pays the time value until the next settlement day. In return he holds a new contract at the settlement price.

1.4 Possible clientele and differential information aspects

It is fair to say that the organization of the forward markets was superior: it was fully computerized, and therefore faster, already by the late 80s; had a pre-market that revealed the market consensus and reduced the impact of accidental imbalances that would otherwise have plagued the opening call; enjoyed lower costs and no price limits; and was much deeper. Figure 1 reports the eight-year mean of the volume ratio, forward to spot, for each stock. Note that the 71 selected stocks are ranked from low to high ratio. We see ratios going from 2.5 to 250; more fairly perhaps, when stocks are put into three relative-volume buckets, each of 24 stocks, the average relative volume per bucket goes from about 10 to 50.

In addition (or, perhaps, as a result of the above), conventional wisdom within the financial community held that there also was an clientele- and efficiency-related form of segmentation.[6] Indeed, because of its shorting facilities and the absence of price limits, the forward market had a somewhat more speculative reputation, to the extent that conservative firms (such as the major banks) have long resisted a forward listing. Because of this speculative image, the forward market was considered to be the market for the more professional agents, while less sophisticated investors were said to prefer the spot market. Having no systematic and fast access to news during working hours, these amateur traders allegedly reacted slower than the professionals. In the terminology of Garbade and Silber (1983), this view hypothesizes that the forward market was the price discoverer, while the spot market was just a (lagging) satellite market. This hypothesis is the central issue of the dissertation.

We conclude the descriptive section with some information on the data.

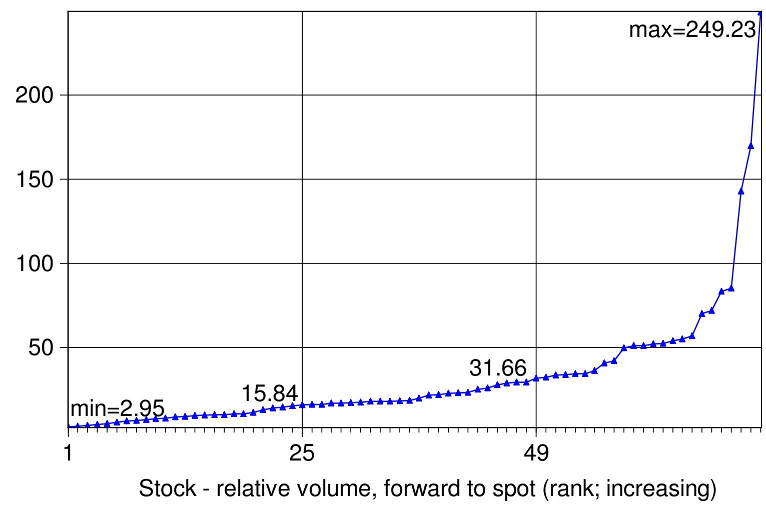
1.5 Data Description

The sample period starts in early 1989, at which time the forward market was fully computerized, and it ends in 1996. In 1997, the forward market disappeared. Euronext's historic-data CDs for that period include the opening spot price per day, and, for the forward market, the daily opening, high and low, and close price. Data on dividends, bonus dividends, splits, and rights issues[7] were missing, and were hand-collected from *Memento der Effecten*, a trade pub-

[6] We are indebted to the late Prof. Van Essche for this suggestion.

[7] A subscription right is represented by a coupon designated for the purpose and it is traded separately the moment the stock goes ex this coupon. The market values of these "scripts" are very noisy so we worked with

Figure 1: **Mean of Volume Ratio, Forward to Spot**



lication, and from *De Tijd*, which published the Dutch-language version of the Official Price List. For the risk-free rate, we used the Euro-BEF 1 week middle rate from Datastream.

We discarded foreign stocks, about half of the list, since price discovery for these shares probably happens abroad anyway. So we started from data on 119 Belgian stocks traded on both the spot and forward tiers of the Brussels Stock Exchange during the period 1989-1996. Some data cleaning was required: 16 stocks are excluded due to an insufficient number of observations (too many missing data points), 31 stocks are connected to other shares due to a change in the name or code after a stock split or merger. Thus, 72 stocks remain. All unusually large forward premiums or large changes in the prices were double-checked with the prices posted on the hard copies of *De Tijd*, including the next-day rectifications for typos. All prices that are indicated 'sellers reduced', 'buyers reduced', or 'indicative', were considered to be missing observations. Whenever there is a missing price, the two returns that are associated with that price are missing too. That is, we never use cumulated returns straddling some missing price.

As the risk-free rate we used the one-week call-money rate and the [calendar days]/360 time convention that then applied outside the interbank market for BEF.

We mainly use the opening prices for our empirical analysis. We would have liked to work

the standard instrinsic value of a subscription right.

Table 3: **Trading Frequency and One-day Return Variance across Turnover Classes**

sample	Number of Returns		Average Variance		Median Variance	
(by turnover)	Spot	Forward	Spot	Forward	Spot	Forward
All	95,668	87,957	3.26	3.43	2.23	1.91
Low turnover	27,605	21,772	4.55	5.17	2.77	2.11
Medium turnover	31,192	29,324	3.23	3.12	1.92	1.66
High turnover	36,871	36,861	1.99	2.00	1.61	1.88

Key: Each turnover class contains 24 stocks, and ranking is done on the basis of average daily turnover.

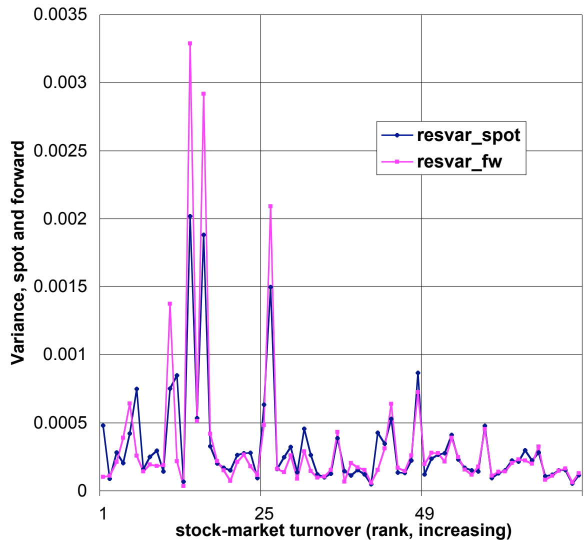
with the close prices too, but for unknown reasons, close prices are missing quite often. Eight years of data means over 2000 trading days. The number of effectively available observations is very variable, ranging from below 50% to 100%. There is a clear relation with the market activity. As can be seen in Table 3, the firms in low-, medium-, and high-turnover groups on average trade 55, 62, and 74 percent of the time, respectively, in the spot market. In the forward market, the corresponding numbers are 43, 58, and 74 percent. Forward markets more often have missing prices than spot markets despite their higher turnovers and the absence of price limits. This probably reflects the interventions by the spot market's specialists mentioned in Section 1.2. There is also a strong negative relation between turnover and return variance, *prima facie*, as also illustrated via Figure 2. Much of that, however, seems to be due to the outliers: when we consider medians, the schedule is much flatter.

By way of caveat, note that the variances in the text table offer just a rough first picture. It ignores, for instance, the fact that the spot market was active on more days than the forward tier, and that days where the forward market did not manage to reach equilibrium may also have been unusually illiquid and noisy days in the spot market.

2 Momentum in Forward Premiums

In order to investigate the behavior of the spot-forward price discrepancies, we first look at the autocorrelation of the forward premiums and find strong, pervasive momentum. Furthermore, an event study reveals that the autocorrelations of forward premiums seem to be very different depending on their sign, and that such an sign-related asymmetry actually holds for the frequencies and average absolute sizes of the premiums too (subsection 1).

Figure 2: **Variances of daily returns, spot v forward; opening prices, all days**



2.1 Characterisation of prices in a noisy-markets setting

Let v_t denote an unobservable true value based on full and correct use of all relevant available information, expressed as a price for immediate payment and delivery. Since neither the actual spot nor forward prices imply immediate settlement, the corresponding true "spot" and forward values, denoted as s and f, should contain a settlement effect shown below, with n_s and n_f denoting the number of calendar days to settlement and R the simple *per diem* interest rate. In addition, actually observed prices are assumed to deviate from true values by a zero-mean, i.i.d. noise term, denoted by ϵ_s or ϵ_f, respectively, which reflects unanticipated orders by liquidity traders and noise traders, as standard in microstructure models:[8]

$$\text{noise-free prices: } s_{t+\tau} = (1 + n_{s,t}R_t)v_{t+\tau}, \tag{1}$$

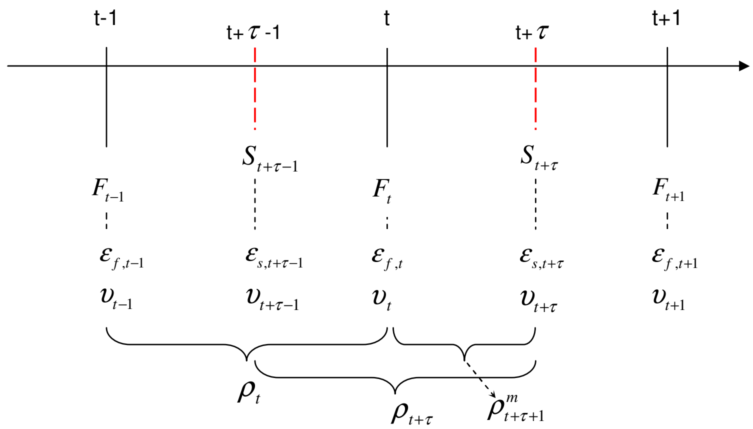
$$f_t = (1 + n_{f,t}R_t)v_t, \tag{2}$$

$$\text{observed prices: } S_{t+\tau} = s_{t+\tau}(1 + \epsilon_{s,t+\tau}) = v_{t+\tau}(1 + n_{s,t}R_t)(1 + \epsilon_{s,t+\tau}), \tag{3}$$

$$F_t = f_t(1 + \epsilon_{f,t}) = v_t(1 + n_{f,t}R_t)(1 + \epsilon_{f,t}). \tag{4}$$

[8]Liquidity traders place orders to park excess cash balances or solve cash shortages; they do so at the market price without questioning its appropriateness. Noise traders act on false beliefs or rumors. Either type of trade could drive prices away from the true value. Informed traders do perceive the true value (or a good approximation to it), and by their trades reduce the gap between true and quoted values. Still, such corrective action is either instantaneous nor costless.

Figure 3: **Asynchronism of Spot vs Forward Prices**



Key: t is at 10 a.m. and $t+\tau$ is at 1:30 p.m.

with $\mathrm{E}_{t-\triangle}(\epsilon_{s,t+\tau}) = 0 = \mathrm{E}_{t-\triangle}(\epsilon_{f,t})$ for any positive $\triangle$; time t refers to 10 a.m., the opening of the forward market; and time $t+\tau$ refers to approximate 1:30 p.m., the opening time of the spot market.

From these models, the forward premium, $\ln(F/S)$, is obtained by subtracting the two log-price equations, the logs of (3) and (4):

$$\begin{aligned} p_t =: \ln\left(\frac{F_t}{S_{t+\tau}}\right) &= \ln\left(\frac{1+n_{f,t}R_t}{1+n_{s,t}R_t}\right) + \ln\left(\frac{v_t}{v_{t+\tau}}\right) + e_{f,t} - e_{s,t+\tau}, \\ &=: \Delta(n_s^f R)_t - \rho^m_{t+1} + e_{f,t} - e_{s,t} \end{aligned} \tag{5}$$

where r is the observed return (or percentage price change, including any coupon detached between $t-1$ and t); $\Delta(nR)_t$ is the theoretical settlement effect in the left-hand-side variable, *i.e.* $\ln[(1+n_{f,t}R_t)/(1+n_{s,t}R_t)$; ρ_t^m is the true return in the morning (10 a.m.—1:30 p.m.); and e_t the percentage noise added in the time-t price. In short, because of the asynchrony there still is a signal in the data, but relative to daily returns in microstructure studies our data reflect less true value changes relatively to noise.

2.2 Autocorrelation in the forward premiums

In order to investigate the behavior of the forward premiums, we purge the settlement effect from the data and work with the settlement-corrected forward prices and premiums, denoted as ones with primes, as follows:

$$
\begin{aligned}
F'_t &:= F_t \frac{1 + n_{s,t} R_t}{1 + n_{f,t} R_t}, && (6)\\
p'_t &:= ln \frac{F'_t}{S_{t+\tau}}, && (7)\\
&= -\rho^m_{t+1} + e_{f,t} - e_{s,t+\tau}. && (8)
\end{aligned}
$$

In this section, whenever we use the words forward price and forward premium, these should always be understood to be time-value-adjusted.

In integrated and frictionless markets, the expected synchronous prices that emerge from the opening calls should be identical:

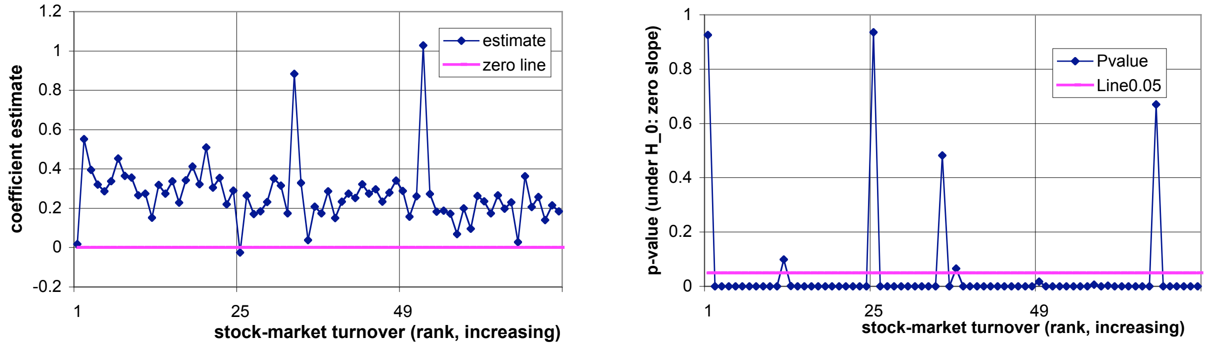
$$
\mathrm{E}_{t-\triangle}(S_t) = \mathrm{E}_{t-\triangle}(F'_t), \tag{9}
$$

for any positive $\triangle$. From this it follows that realized forward premiums should be unpredictable, implying, for instance, zero autocorrelation in the realized premiums. While the forward premium is theoretically the difference of the pricing errors in the synchronous case, when the prices are asynchronous the premiums involve the additional morning true return term ρ^m_{t+1} as shown in (8). Therefore, a non-zero mean or autocorrelation of the realized premiums could come from either the morning true return, or the pricing errors, or both. In the remaining part of this subsection, we investigate the autocorrelation of the premiums and its possible sources. We shall see that the results are such that they cannot soley or even largely come from the morning-return term. In the final section, when examining the implication of the mean forward premiums, we even ignore the expected morning true return because of its trivial magnitude.

Figure 4 summarizes the estimated autocorrelations of the forward premiums for the individual stocks visually, while Table 4 provides some numerical information. In the graph we plot the 72 coefficients for the stocks ranked by increasing turnover. The obvious conclusion is that autocorrelation is positive: out of the total 72 cases, only one estimate actually is negative, and only marginally at that, while 66 cases or 91.7% of the estimates are significantly positive. Both the graph and the table show that the averages and the number of significant rejections tend to fall the more active the stock is, but the effect is quite slight: the general average coefficient is 0.27, falling from 0.32 to 0.24 as we go from thinly to actively-traded stocks; the medians tell a similar tale. The aggregate estimates shown in the "panel estimation" part of

Figure 4: **Autocorrelation in the Forward Premiums, Stock by Stock.**

$$\mathrm{E}_{t-\Delta}\left(\frac{F'_t - S_t}{S_{t-1}} | S_{t-1}, F'_{t-1}\right) = \rho_0 + \rho_1 \frac{F'_{t-1} - S_{t-1}}{S_{t-1}}$$



Key: *Ex-post* forward premiums for 72 stocks are regressed on their lagged value. This slope, ρ_1, estimates the scaled autocovariance of the forward premiums. A zero ρ_1 means that forward premiums are not correlated, a positive one signals positive autocorrelation in premiums, meaning that the true-morning-return is also autocorrelated of first-order. We show estimated rhos and their p-values for all stocks, arranged by daily average turnover. Estimates per stock are plotted for stocks ranged by turnover rate. For visibility, the dots are linked by line segments, but any similarity to a time-series plot is unintended.

the table[9] are very similar to the straightforward means of individual estimates, and are clearly different from zero. All this again indicates that the forward premium is positively autocorrelated. Autocorrelation in the morning true returns could be a source of autocorrelation in price discrepancies, but it is almost unthinkable, in an efficient market, that the true returns could generate daily autocorrelation of 0.3.[10] So, the results imply that the noise part in the forward premiums are predictable, which is a sign of inefficiency or at least a reflection of an imperfection. The phenomenon occurs across the entire spectrum of trading volume.

2.3 Event study

To see whether autocorrelation is pervasive, or confined to, for instance, rare extreme outliers, we add an event study. Table 5 shows average abnormal forward premiums in the period of 1 to 10 days after an 'event', with the event being defined as a forward premium falling in the

[9] Average or aggregate values can be obtained by running panel regressions with a common slope, as long as deviations from the common slope are independent. For aggregates obtained via panel regression we test the independence assumption by regressing, for every equation, the 72 slopes on the corresponding turnovers. For the sample as a whole there is, unsurprisingly, a significant negative relation, but within turnover groups there is no more clear link (Table 10 in the appendix).

[10] Also, we see no such high autocorrelation in either spot or forward daily returns.

Table 4: **Test of Autocorrelation in the Forward Premiums.**

$$\mathrm{E}_{t-\Delta}\left(\frac{F'_t - S_t}{S_{t-1}}|S_{t-1}, F'_{t-1}\right) = \rho_0 + \rho_1 \frac{F'_{t-1} - S_{t-1}}{S_{t-1}}$$

sample	individual series estimation					panel estimation			
(by turnover)	mean	median	$n_{>0}$	sgnf$_{>0}$	sgnf$_{<0}$	$\hat{\rho}_1$	SE(.)	t-stat	prob
All	0.27	0.26	71	68	0	0.29	0.011	25.33	0.0000
Low turnover	0.32	0.32	24	23	0	0.32	0.022	14.30	0.0000
Medium	0.26	0.26	23	22	0	0.27	0.016	17.08	0.0000
High	0.24	0.20	24	23	0	0.26	0.012	21.50	0.0000

Key: *Ex-post* forward premiums for 72 stocks are regressed on their lagged value. A zero ρ means that forward premiums are not correlated, a positive one signals positive autocorrelation in premiums, meaning positive autocorrelation in the true-morning return. We show summary statistics for all stocks and for three subsamples of stocks arranged by daily average turnover.

interval 2 to 3%, 3 to 4%, and larger than 4%, respectively, and similarly for negative premiums. The result is that, after negative mispricing irrespectively of the size, the next-day abnormal premium was close to zero. The result for positive premiums is different: conditional on an unusually high initial forward premium, it takes several days for the abnormal premium to decay towards zero. Typically, one-third of a large positive premium is still there the next day, against about one-tenth for negative outliers. The phenomenon of conditional autocorrelation is most pronounced with the less active stocks. An additional striking fact is that positive extreme events are at least 2.5 times more frequent than negative ones. In the next section we provide a framework that can explain these phenomenons.

3 Forward Premiums in the Presence of Financing and Shorting Costs

From the above, there seems to be something else going on rather than just *ex ante* arbitraging, *i.e.* selecting the market that is likely to offer the best opening price. Standard transaction costs may affect the choice between the tiers, but the differences are small, as we saw. Moreover, if standard transaction costs were the main imperfection in the market, there would never be any spot trades since their cost is higher; so there must be something else. Other imperfections that come to mind are costs of shorting—the hassle and delay and commission paid when finding a party that lends shares or provides money. We denote these costs, or their monetary equivalent for individual i, by C^i_s (borrowing *S*hares) or C^i_m (borrowing *M*oney), respectively.

Table 5: **Average Abnormal Forward Premiums: Event Study**

		positive events										
$\in [2\%, 3\%)$	# of events	day 0 (%)	day 1 (%)	day 2 (%)	day 3 (%)	day 4 (%)	day 5 (%)	day 6 (%)	day 7 (%)	day 8 (%)	day 9 (%)	day 10 (%)
All	4099	2.38	0.95	0.75	0.66	0.53	0.54	0.56	0.48	0.49	0.48	0.52
Low turnover	1823	2.42	1.21	1.02	0.93	0.68	0.68	0.69	0.58	0.59	0.64	0.58
Medium	1317	2.38	0.83	0.68	0.57	0.45	0.51	0.51	0.45	0.53	0.49	0.62
High	959	2.35	0.80	0.56	0.47	0.46	0.45	0.48	0.43	0.37	0.32	0.36
$\in [3\%, 4\%)$	# of events	day 0 (%)	day 1 (%)	day 2 (%)	day 3 (%)	day 4 (%)	day 5 (%)	day 6 (%)	day 7 (%)	day 8 (%)	day 9 (%)	day 10 (%)
All	1485	3.42	1.20	0.81	0.63	0.66	0.73	0.57	0.50	0.58	0.52	0.52
Low turnover	765	3.45	1.51	1.00	0.92	0.83	0.98	0.80	0.82	0.78	0.73	0.70
Medium	418	3.39	1.43	0.87	0.58	0.76	0.90	0.51	0.38	0.64	0.53	0.41
High	302	3.42	0.70	0.55	0.39	0.39	0.32	0.38	0.27	0.31	0.30	0.43
$\geq$4%	# of events	day 0 (%)	day 1 (%)	day 2 (%)	day 3 (%)	day 4 (%)	day 5 (%)	day 6 (%)	day 7 (%)	day 8 (%)	day 9 (%)	day 10 (%)
All	1309	5.33	1.36	1.01	0.77	0.80	0.72	0.64	0.62	0.67	0.66	0.66
Low turnover	804	5.51	2.19	1.53	1.27	1.21	1.10	0.99	0.82	1.03	0.95	1.01
Medium	373	5.32	1.32	0.94	0.73	0.67	0.68	0.43	0.60	0.54	0.38	0.50
High	132	5.14	0.53	0.52	0.27	0.46	0.35	0.49	0.42	0.40	0.64	0.45

		negative events										
$\in (-3\%, -2\%]$	# of events	day 0 (%)	day 1 (%)	day 2 (%)	day 3 (%)	day 4 (%)	day 5 (%)	day 6 (%)	day 7 (%)	day 8 (%)	day 9 (%)	day 10 (%)
All	1685	-2.41	-0.17	0.06	0.17	0.31	0.18	0.30	0.24	0.16	0.26	0.23
Low turnover	568	-2.43	-0.22	0.11	0.34	0.49	0.42	0.47	0.27	0.42	0.36	0.37
Medium	621	-2.41	-0.16	0.15	0.18	0.36	0.11	0.20	0.23	0.01	0.26	0.25
High	496	-2.40	-0.15	-0.07	-0.01	0.09	-0.01	0.23	0.21	0.05	0.18	0.07
$\in (-4\%, -3\%]$	# of events	day 0 (%)	day 1 (%)	day 2 (%)	day 3 (%)	day 4 (%)	day 5 (%)	day 6 (%)	day 7 (%)	day 8 (%)	day 9 (%)	day 10 (%)
All	593	-3.41	-0.41	-0.04	0.08	0.14	0.06	0.00	0.08	0.20	0.19	0.24
Low turnover	208	-3.42	-0.51	0.00	0.09	0.33	0.16	0.11	0.10	0.57	0.49	0.43
Medium	273	-3.38	-0.37	0.16	0.10	0.17	0.23	-0.19	0.00	-0.10	0.21	0.17
High	112	-3.44	-0.35	-0.29	0.05	-0.12	-0.21	0.06	0.14	0.09	-0.19	0.10
$\leq$-4%	# of events	day 0 (%)	day 1 (%)	day 2 (%)	day 3 (%)	day 4 (%)	day 5 (%)	day 6 (%)	day 7 (%)	day 8 (%)	day 9 (%)	day 10 (%)
All	500	-5.20	-0.43	-0.12	0.25	-0.07	0.30	0.35	0.23	0.16	0.17	0.26
Low turnover	224	-5.29	-0.64	-0.31	0.46	-0.27	0.60	0.28	0.33	0.31	0.12	0.65
Medium	217	-5.25	-0.36	0.06	0.09	-0.14	0.11	0.60	0.13	0.08	0.25	0.14
High	59	-5.03	-0.22	-0.09	0.16	0.26	0.10	0.13	0.23	0.04	0.14	-0.09

Key: We show the average realized forward premium on days 1, ... 10 following an event, the event being defined as a forward premium (shown in the column for day 0) between 2 and 3%, or between 3 and 4%, or exceeding 4%, and similarly for the negative side. We expect a zero mean, in well-integrated and well-functioning markets. 'All' refers to all stocks. 'Low', 'Medium' and 'High' refer to subsamples of 24 stocks each, assembled on the basis of average daily turnover.

Table 6: **Conditions for trading forward instead of spot**

type of trade	(condition on F')	(condition on $F' - S$)
buy, no constraint	$F' \leq S$	$F' - S \leq 0$
buy, cash constrained	$F' \leq S + C_m$	$F' - S \leq C_m$
buy to close an initial short position	$F' \leq S - C_s$	$F' - S \leq -C_s$
sell, no constraint	$F' \geq S$	$F' - S \geq 0$
sell, cash constrained	$F' - C_m \leq S$	$F' - S \geq C_m$
sell, no long position	$F' \geq S + -C_s$	$F' - S \geq -C_s$

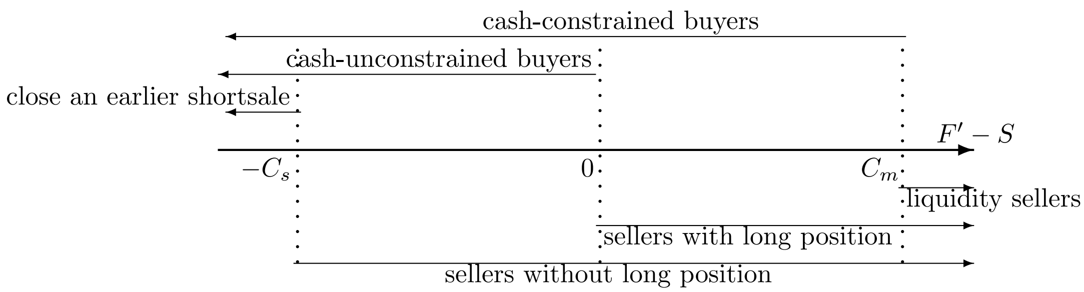
3.1 The effect of funding and shorting costs: testable hypotheses

Suppose, initially, that we have a quote-driven market with zero spreads and that the costs are either zero (for buyers with cash, or sellers with a long position) or assume the same value, *i.e.* C_m for all individuals facing liquidity problems and C_s for all sellers that have no long position. We distinguish six types of trades, three of them buyers and three sellers. In the case of buying, liquidity traders may include some agents who need to deliver shares because of an earlier short sale. They could buy spot at a price S or buy forward and borrow shares at a cost $F' + C_s$; therefore, such buyers would buy forward if the spot price is higher than the forward price plus the cost C_s. Regular liquidity traders, as well as informed or speculative buyers that face no cash constraint, would simply compare both prices. Lastly, informed or speculative buyers who are short of cash compare F' with the cost of a levered spot deal, $S + C_m$.

In the case of selling, similar results hold. Liquidity traders would sell forward and get a loan if the forward price minus the cost of borrowing exceeds the spot price. Information or speculative sellers, in contrast would sell forward if the forward price is above the spot price minus, if relevant, the cost of borrowing shares, C_s. In Table 6 we show for each of these six relevant potential clienteles the condition on forward premium that would steer the deal to the forward market.

These six conditions are visualized in Figure 5, with each time a half-line indicating the range of forward premiums that would direct these trades towards the forward market. (The costs C_m and C_s are shown as equally large, but this is just for illustrative purposes.) Unsurprisingly, there is a potential match of supply and demand in the whole range $[-C_s, C_m]$, instead of the standard perfect-markets solution $F' - S = 0$. We see that liquidity-driven sellers should find no counterparts save, at the margin, cash-constrained buyers; most liquidity-driven sales should therefore be done spot. So if we see a positive forward premium, this means that

Figure 5: **Ranges of acceptable forward premiums for various clienteles**



the order volume from cash-constrained buyers exceeds that of sellers without a long position unless, implausibly, there is not a single seller who actually holds the stock, initially. Likewise, if we observe a negative forward premium, the order volume from sellers without long positions should exceed that of cash-constrained buyers except on unlikely days with absolutely no buyers who do have enough cash at hand.

In the above, we assumed firm quotes. If we have an order-driven market instead, the analysis still works for limit orders, provided the probability of execution is similar across segments. For market orders, the numbers F' and S have to be interpreted as expected opening prices. Realized prices would always differ from expectations, but in a purely random way; so if we see mostly positive forward premiums, this would still means that, on a modal day, the order volume from cash-constrained buyers exceeds that of sellers without a long position.[11]

In light of all this, we look at the forward premiums as follows:

1. The frequencies of realized premiums $F' - S$ grouped per sign provide an indication of which clientele is most often the active marginal group in the forward market, with positive premiums suggesting an ascendency of liquidity-constrained buyers and vice versa.

   From the frequencies per se we do not know whether a higher incidence of, say, forward premiums reflects higher financing costs relative to shorting costs: it might equally well mean that noise traders tend to be bearish more often than bullish. But if we would observe that premiums are not only more frequent but also larger in absolute terms than

[11]The analysis does not provide a unique value of $F' - S$; for this, one would have to assume heterogeneity in the costs and/or in the expected opening prices S and F', so that the supply and demand schedules would be less stepwise than what we have here. For current purposes, we do not need that refinement.

discounts, there is a positive implication for costs:

2. The mean values of absolute realized premiums $F' - S$ per sign are bounded by the costs C_m or C_s, so they provide an indication of the size of the shorting and borrowing cost. For instance, if positive premiums are typically larger, *i.e.* if buyers are prepared to pay a relatively big premium for a forward solution, this suggest that the cost of getting a loan exceeds the cost of shorting a share.

3. The persistence of the premiums per sign provides an indication about the persistence of particular clientele effects. For example, if speculative or informed purchases from cash-constrained come in waves that last more than a day, positive premiums would tend to persist. Persistence then strongly suggests that the effect is due to such a wave of clientele trades rather than to unexpected forward premiums reflecting random imbalances in the order book.

In short, we want to explore the findings suggested by the event study in a more systematic fashion, including significance tests.

3.2 Frequency Test

In order to examine the probability of positive v.s negative forward premiums, we run the following regression:

$$\mathit{SIGN} - 0.5 = \alpha_1 + \beta_1[\mathit{SIGN}(-1) - \overline{\mathit{SIGN}(-1)}]. \tag{10}$$

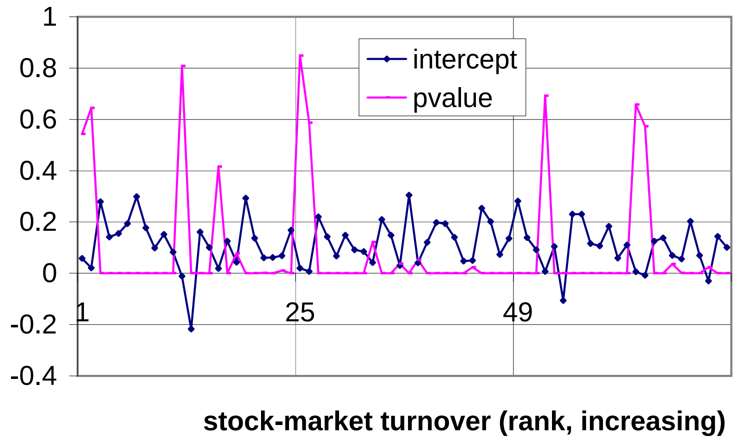
where $x(-1)$ refers to x lagged and $\overline{x}$ to the time-series average of x; $\mathit{SIGN} = 1$ if the forward premium is positive, and $\mathit{SIGN} = 0$ otherwise.

Let f^- and f^+ denote the probability of positive and negative forward premiums, respectively. The coefficient α_1 in equation (10) provides an estimate of $(f^+ - 0.5)$. If α_1 is positive, then $f^+ > 0.5$ and $f^- < 0.5$, meaning that the forward premiums are positive with higher probability. The regression equation includes the lag of the *SIGN* variable to control for the autocorrelation of the error terms in the significance test. Figure 6 and Table 7 report the result of the test for the significance of the α_1 estimate, in which the Newey-West standard errors are used.

The obvious feature is that the α_1 estimates are significantly positive for almost all stocks. Out of the total 72 cases, the estimates are positive 67 times, *i.e.* in 93% of the cases, and

Figure 6: **Frequency Test**

$$SIGN - 0.5 = \alpha_1 + \beta_1(SIGN(-1) - \overline{SIGN(-1)})$$



Key: In the frequency test equation, $SIGN = 1$ if the forward premium is positive, and $SIGN = 0$ otherwise. If α_1 is positive, then the probability of positive forward premiums is higher than 0.5, *i.e* $f^+ > 0.5$ and $f^- < 0.5$, meaning that the forward premiums are positive with higher probability.

Table 7: **Frequency of Positive Premiums per Sign**

Frequency test: $SIGN - 0.5 = \alpha_1 + \beta_1[SIGN(-1) - \overline{SIGN(-1)}]$

	mean α_1	median	positive	sgnf>0	negative	sgnf<0
All	0.112	0.109	67	57	5	3
Low turnover	0.111	0.113	22	18	2	1
Medium	0.124	0.129	24	20	0	0
High	0.101	0.106	21	19	3	2

Key: In the frequency test equation, $SIGN = 1$ if the forward premium is positive, and $SIGN = 0$ otherwise. If α_1 is positive, then the probability of positive forward premiums is higher than 0.5, *i.e* $f^+ > 0.5$ and $f^- < 0.5$, meaning that the forward premiums are positive with higher probability.

in 57 of these 67 cases (79%) significantly so. This feature comes up similarly in all the three subgroups: out of 24 cases in each of the low-, medium-, and high-market turnover groups, the estimates are positive in 22 (92%), 24 (100%), and 21 (88%) cases, respectively, of which 18 (75%), 20 (83%), 19 (79%) are significantly so. This result means that $f^+ > 0.5$—the forward premium is positive more frequently—in the vast majority of the cases. The order of magnitude seems to be over 60% positive against less than 40% negative price gaps. This includes also the smaller price discrepancies; from the event study we remember that, for equal absolute cut-off levels of 2% or more, there are 2.5 to 3 times more positive forward premiums.

Table 8: **Conditional Mean of Forward Premiums per Sign**

$|\frac{F'-S}{S(-1)}| = \alpha_2(1-\mathit{SIGN}) + \beta_2\mathit{SIGN} + \gamma_2\mathit{SIGN}(-1) + \delta|\frac{F'-S}{S(-1)}|(-1)$

	α_2 negpremiums		β_2 pospremiums		$(\beta_2-\alpha_2)$					
	mean	median	mean	median	mean	median	$n_{>0}$	sgnf$_{>0}$	$n_{<0}$	sgnf$_{<0}$
All	0.006	0.005	0.009	0.008	0.0025	0.0026	70	47	2	0
Low turnover	0.007	0.007	0.011	0.011	0.0043	0.0035	24	17	0	0
Medium	0.007	0.005	0.008	0.007	0.0015	0.0025	23	15	1	0
High	0.005	0.004	0.006	0.006	0.0018	0.0018	23	15	1	0

Key: α_2 and β_2 estimate the mean of negative and positive forward premiums in absolute term, respectively. The graph on the left shows α_2 and β_2 estimates for each stock. The one on the right shows the difference of the means, $(\beta_2-\alpha_2)$, and its t-statistics, in which the Newey-West standard error is used.

3.3 Conditional Mean of Forward Premium per Sign

In order to compare the shadow cost of getting a loan and the cost of shorting a share, we compare the absolute realized premium $F'-S$ per sign. To this end, we regress the following equation:

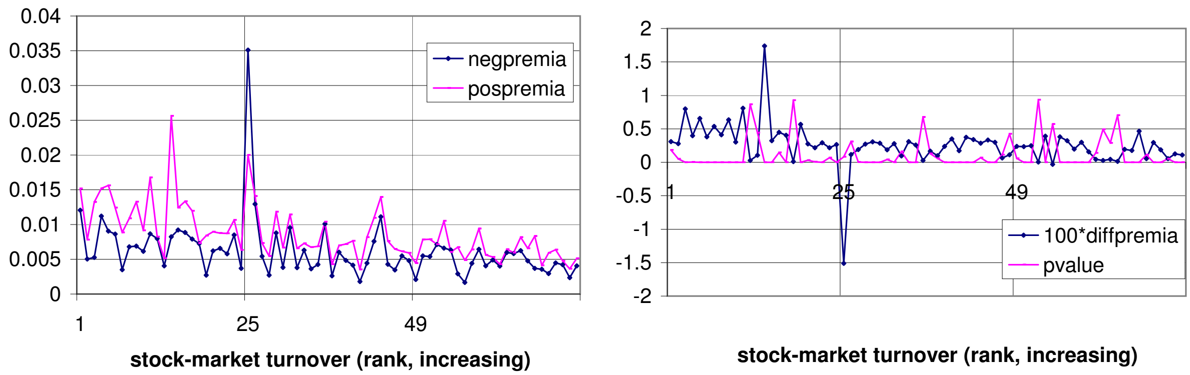
$$|\frac{F'-S}{S(-1)}| = \alpha_2(1-\mathit{SIGN}) + \beta_2\mathit{SIGN} + \gamma_2\mathit{SIGN}(-1) + \delta|\frac{F'-S}{S(-1)}|(-1). \tag{11}$$

where $|\frac{F'-S}{S(-1)}|$ is the absolute value of the percentage forward premiums; $\mathit{SIGN} = 1$ if the forward premium is positive, and $\mathit{SIGN} = 0$ otherwise.

The coefficient α_2 and β_2 estimate the mean of negative and positive forward premiums in absolute terms, respectively. If $(\beta_2-\alpha_2)$ is positive, the mean of positive premiums is higher the mean of negative premiums. Equation (11) includes the lag of the variables *SIGN* and $|\frac{F'-S}{S(-1)}|$ to control for the autocorrelation and heteroskedasticity of the regression error terms. Figure 7 and Table 8 summarize the result. The general picture is that the estimates of $(\beta_2-\alpha_2)$ are positive in almost all of the cases: 70 (97%), 24 (100%), 23 (96%), and 23 (96%) cases out of the total 72 cases, and out of the 24 cases in each of the low-, medium-, and high-turnover market sections, respectively. The estimates are significantly positive in 47 (65%), 17 (71%), 15 (63%) and 15 (63%) cases in the total group, and the low-, medium-, and high-turnover groups, respectively. This result means that a positive premium was typically higher than a negative premiums, in absolute terms, for almost each and every stock, suggesting that the total cost of getting a loan exceeds the cost of shorting a share.

Figure 7: **Conditional Mean of Forward Premiums per Sign**

$$|\frac{F^{'}-S}{S(-1)}| = \alpha_2(1-SIGN) + \beta_2 SIGN + \gamma_2 SIGN(-1) + \delta|\frac{F^{'}-S}{S(-1)}|(-1)$$



Key: α_2 and β_2 estimate the mean of negative and positive forward premiums in absolute term, respectively. The graph on the left shows α_2 and β_2 estimates for each stock. The one on the right shows the difference of the means, which is multiplied by 100 in the graph, *i.e.* $100*(\beta_2-\alpha_2)$, and its t-statistics, in which the Newey-West standard error is used.

3.4 Autocorrelation per Sign

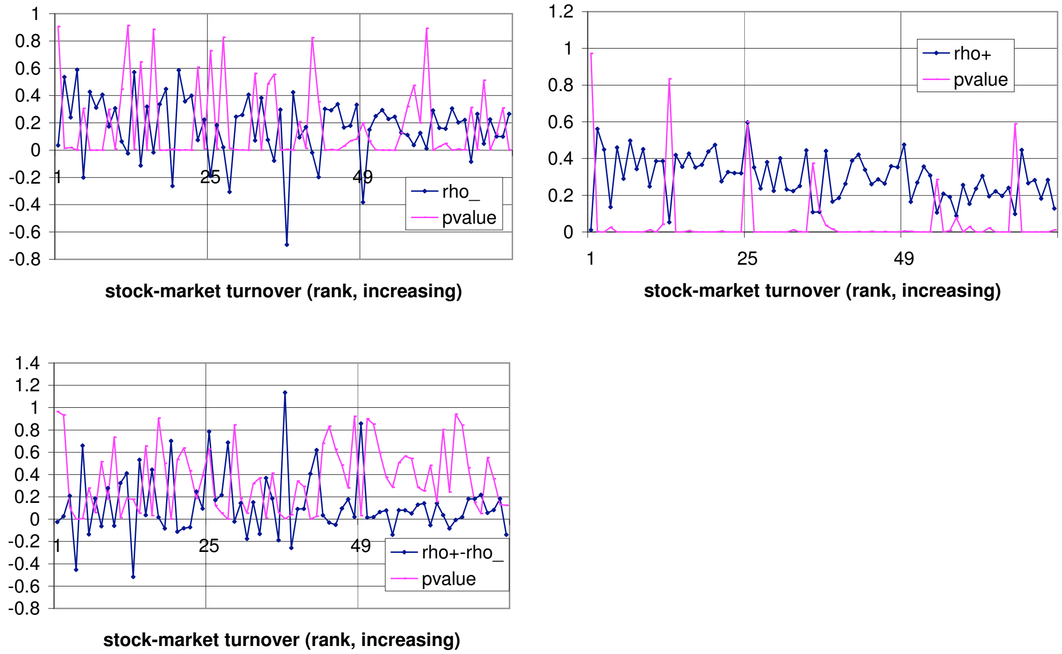
To examine the dependence of the forward-premium autocorrelation on the sign of forward premiums, we regress the following equation:

$$F^{'} - S = \rho_0 + \rho_-(F^{'}-S)(-1)*(1-SIGN(-1)) + \rho_+(F^{'}-S)(-1)*SIGN(-1). \quad (12)$$

The coefficients ρ_- and ρ_+ estimate the autocorrelation coefficients given the negative and positive forward premium, respectively. Figure 8 and Table 9 provides the regression results. Two observations stand out. First, the autocorrelation coefficient estimates given positive forward premiums ρ_+ are significantly positive in almost all of the cases, while the coefficient estimates given negative premiums ρ_- are significant in far fewer cases. Out of the total 72 cases, the ρ_+ estimates are significant in 67 cases (89%), all of which are positive, while the ρ_- estimates are significant in 43 cases (60%), 40 (3) of which are positive (negative). In addition, the ρ_+ estimates are positive all the 72 cases (100%) and the ρ_- estimates are so in only 59 cases (82%). Second, the size of the coefficients ρ_+ is higher than that of ρ_-. The average of ρ_+ estimates is 0.296, 0.348, 0.304, and 0.236 in the total 72-stock group and low-, medium- and high-turnover subgroups, respectively, whereas the corresponding numbers for the average of ρ_- estimates are around half, *i.e.* 0.167, 0.241, 0.115, and 0.144, respectively. The significance test for the difference of ρ_+ and ρ_- shows that $(\rho_+-\rho_-)$ is positive in 50 (70%), 14 (58%),17 (71%), and 19 (79%) cases in the total 72-stock group and the low-, medium-, and

Figure 8: **Autocorrelation per Sign**

$$F' - S = \rho_0 + \rho_-(F' - S)(-1) * (1 - SIGN(-1)) + \rho_+(F' - S)(-1) * SIGN(-1).$$



Key: The upper left figure reports the estimates of the autocorrelation of forward premiums given the negative premiums in the previous day, *i.e.* ρ_-; the upper right is for negative premiums, *i.e.* ρ_-; and the bottom left is for the difference of the rho, *i.e.* $(\rho_+ - \rho_-)$.

high-turnover subgroups, of which 10, 4, 5, and 1 cases are significantly so, respectively. In all the 22 cases with negative estimates for $(\rho_+ - \rho_-)$, only 2 cases are significant.

The general picture, then, is that positive price discrepancies are significantly more frequent, and on average half as large. In addition, positive premiums tend to persist for more than the negative ones, which makes it unlikely that they are the result of random imbalances between the order books. All this fits in with the view that the marginal traders in the forward market are typically speculative or informed purchases facing a cash-constraint, while liquidity traders deal spot.

Table 9: **Autocorrelation per Sign**

$$F^{'} - S = \rho_0 + \rho_-(F^{'} - S)(-1) * (1 - \mathit{SIGN}(-1)) + \rho_+(F^{'} - S)(-1) * \mathit{SIGN}(-1)$$

	ρ_-					
	mean	median	$n_{>0}$	sgnf$_>0$	$n_{<0}$	sgnf$_<0$
All	0.167	0.193	59	40	13	3
Low turnover	0.241	0.309	19	15	5	1
Medium	0.115	0.174	18	12	6	2
High	0.144	0.160	22	13	2	0
	ρ_+					
All	0.296	0.285	72	64	0	0
Low turnover	0.348	0.360	24	22	0	0
Medium	0.304	0.275	24	21	0	0
High	0.236	0.229	24	21	0	0
	$(\rho_+ - \rho_-)$					
All	0.129	0.080	50	10	22	2
Low turnover	0.107	0.031	14	4	10	1
Medium	0.189	0.120	17	5	7	1
High	0.092	0.071	19	1	5	0

Key: This table reports the regression result for the forward premium autocorrelation per sign. Newey-West standard error is used for the test statistics.

4 Conclusions

Buying forward, in Brussels, offered easy leverage; so if raising funds for a cash trade is costly, the convenience of financing might justify a positive forward premium. Shorting stocks was equally easy, though, if one sold forward; so if shorting in the cash market is costly, this may justify abnormally low forward prices. We study which situation seems to be dominant. A close look at the price discrepancies reveals that shorting difficulties in the spot market are not the dominant issue, as opposed to borrowing restrictions or other problems with quickly raising liquidities. We find that for virtually all stocks (*i*) the probability of positive forward premium is higher than that of negative premium; (*ii*) the mean of positive premiums is higher than that of negative premiums in absolute terms; and (*iii*) autocorrelation of forward premiums given positive premiums is significantly positive and around two times larger than that of the negative premiums. This pattern is consistent with a cash-is-king story, steering buyers to the levered forward market and sellers to the spot tier, rather than with problems in shorting stocks in the cash market. Thus, contrary to what many academics may have expected, getting money loans seems to be a more frequent and more pressing consideration than asset borrowing.

A broader conclusion is that the two prices are not just duplicating each other; they are to some extent different. A layman may then raise the question which of the two is wrong and which is right. We know that forward prices are often too high relative to spot values, but this does not necessarily tell us whether the former are overvalued or, instead, the latter undervalued. Answers in economics are rarely all black versus white, so the more academic question probably is which tends to be faster in reacting, which is typically leading or following, which is more noisy, or less biased, etcetera. These are the topics of the next two chapters.

Appendix: independence tests in the aggregate autocorrelation estimates

Table 10: **Preparing for Panel Estimation: Independence Tests for Slopes**

	slope	t-stat	prob
All	-1.80	-2.63	0.0104
Low turnover	2.96	0.10	0.9199
Medium	12.35	1.90	0.0707
High	-0.37	-0.40	0.6943

Key: In this test, we regress ρ_1 of each stock on its turnover. ρ_1 estimates the scaled autocovariance of forward premiums. To be able to estimate the mean rho via panel regressions with a common slope we need to test that individual stocks' rhos are deviating randomly from a general mean. Here we test whether there is a relation with turnover, first in the all-stock sample and then in the three subsamples of stocks assembled on the basis of average daily turnover.

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